Section 9: Snow Geese

Jerry W. Hupp, Donna G. Robertson, and Alan W. Brackney

Size and Distribution of Snow Goose Populations

Part of the coastal plain of the Arctic National Wildlife Refuge, Alaska, is used as an autumn staging area by lesser snow geese (*Chen caerulescens caerulescens*) from the Western Canadian Arctic population (hereafter called the Western Arctic population). There were approximately 200,000 breeding adults in the Western Arctic population through the mid-1980s (Johnson and Herter 1989), but the population has recently increased to about 500,000 breeding adults (Kerbes et al. 1999).

Early in their autumn migration, adult and juvenile snow geese from the Western Arctic population feed intensively while staging on the Beaufort Sea coastal plain in Canada and Alaska to build fat reserves needed for migration. Aerial censuses from 1973 to 1985 indicated that up to 600,000 adult and juvenile snow geese used the coastal plain for 2-4 weeks in late August until mid-September (Oates et al. 1987).

We studied annual variation in numbers and spatial distribution of snow geese that staged on the coastal plain of the Arctic Refuge.

Numbers and distribution of snow geese on the Arctic Refuge were assessed from aerial surveys during 9 years from 1982-1993 (Robertson et al. 1997). During surveys biologists estimated the numbers of geese in flocks and marked flock locations on topographic maps. Survey results were digitized on a map of the coastal plain. A grid of 25-km^2 cells was superimposed over the digitized map. We tallied the numbers of geese observed in a cell during each survey and the number of years each cell was used by geese.

The numbers of snow geese that staged on the Arctic Refuge ranged from 12,800 to 309,200 individuals across years (Fig. 9.1). The numbers were highly variable because in some years most of the population remained in Canada, whereas in other years the majority of the Western Arctic population staged on the Arctic Refuge.

Snow geese occupied approximately 605,000 ha of the Arctic Refuge coastal plain between the Hulahula River and Canadian border. Only 20% of the 25-km^2 cells were frequently used (i.e., used $\geq$5 years) yet 80% of the frequently used cells fell within the boundaries of the 1002 Area (Fig. 9.2). The mid-coastal plain between the Okpilak and Aichilik rivers was used more frequently than areas near the coast or the steep foothills. Areas that were used frequently were also used by larger numbers of geese. Frequently used areas had more of the landscape

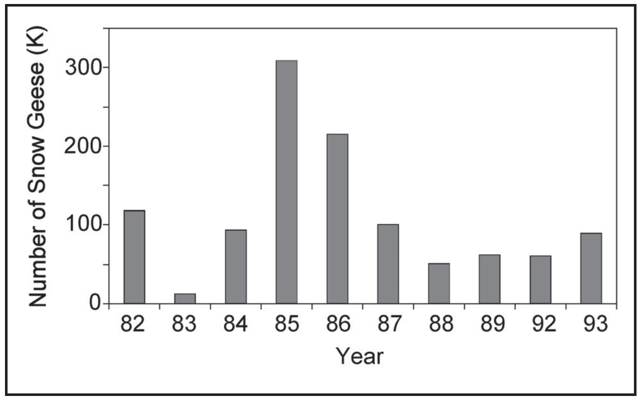

Figure 9.1. Numbers of lesser snow geese observed on the coastal plain of the Arctic National Wildlife Refuge, Alaska, USA, during aerial surveys from 1982-1993. Poor weather prevented surveys in 1990 and 1991.

features snow geese selected when feeding (Hupp and Robertson 1998).

Snow Goose Habitat, Food, and Energy Requirements

The staging area on the Beaufort Sea coastal plain provides forage that geese use to build energy reserves prior to continuing their migration south (Patterson 1974). Upon departure from the coastal plain, snow geese make a 2,000-km-nonstop flight to the next stopover area in northern Alberta (Johnson and Herter 1989). Geese that lack sufficient fat reserves may be less likely to survive migration (Owen and Black 1991).

Because snow geese are easily disturbed by human activity (Davis and Wiseley 1974, Wiseley 1974, Bélanger and Bédard 1989), development of the coastal plain could displace geese from feeding habitats. Exclusion from feeding habitats could reduce the likelihood that staging geese would acquire fat reserves needed for migration. To identify snow goose areas that could be impacted by development, we needed data on forage preference as well as the distribution and availability of feeding habitats.

We studied body condition and diet of snow geese in order to understand their energetic and nutritional demands. We also assessed use and availability of feeding habitats and the effects that grazing geese had on vegetation at these sites.

Body condition and diet of 151 snow geese collected during 1984-85 and 1988 were evaluated (Fig. 9.3). Adult snow geese gained an average of 22 g of body fat/day and departed the Arctic Refuge with about 600 g of fat reserves. Juveniles arrived on the Arctic Refuge with smaller fat reserves than adults, acquired lipid reserves at a slower rate (13 g/day), and departed with smaller reserves (375 g). At the end of staging, juveniles had

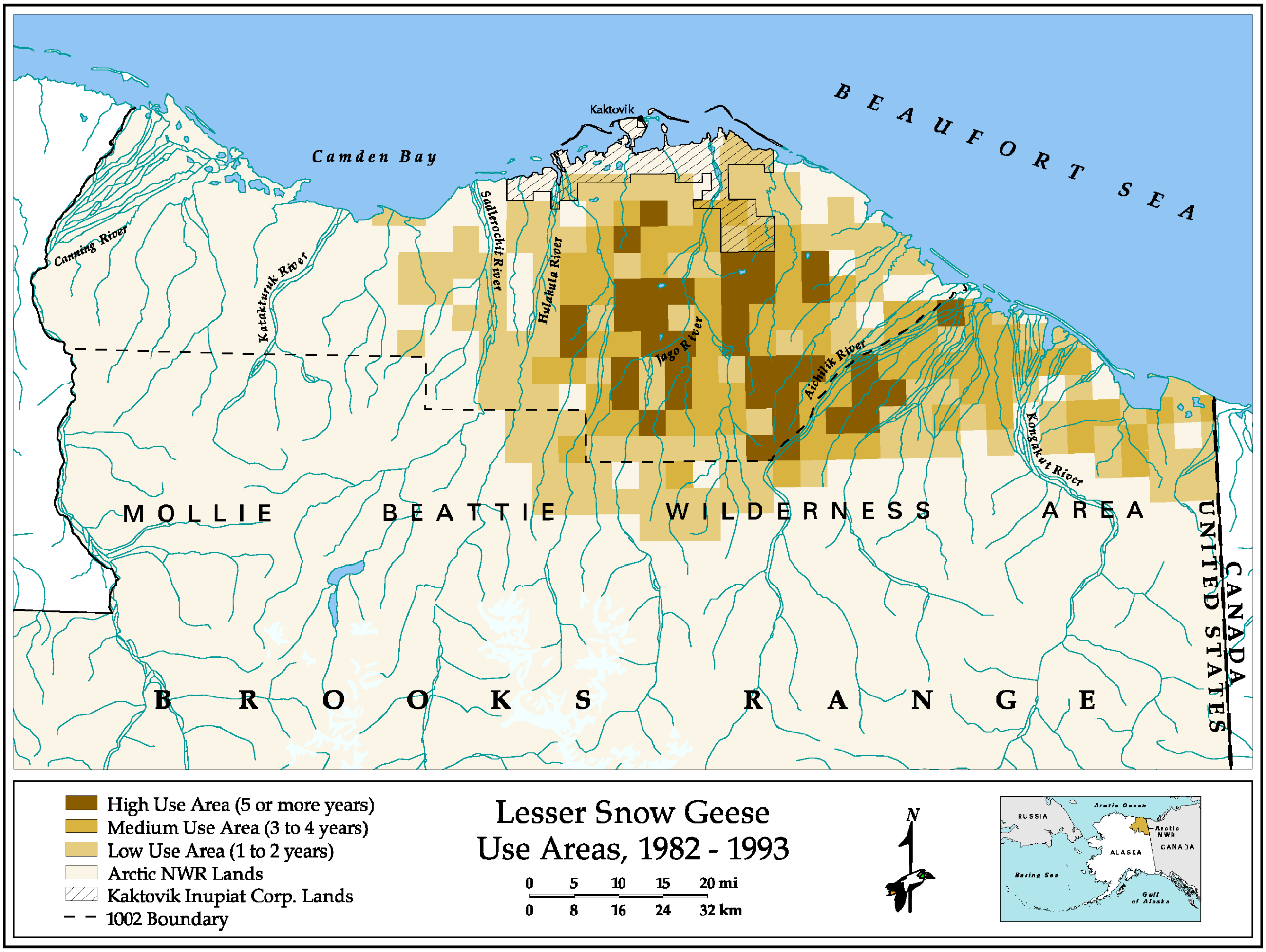

Figure 9.2. Frequency of use of 25-km^2 cells by lesser snow goose flocks on the coastal plain of the Arctic National Wildlife Refuge, Alaska, 1982-1993. Use of cells by snow geese was assessed during aerial surveys.

proportionally smaller lipid reserves (15-18% of body mass) than adults (21-24% of body mass) and likely were at greater risk of having inadequate energy reserves for migration.

We examined esophageal contents of snow geese to identify important forage species (Brackney and Hupp 1993). Snow geese primarily consumed 2 food items: the underground stembase of *Eriophorum angustifolium* (tall cottongrass) and the aerial shoots of *Equisetum variegatum* (northern scouring-rush). The birds typically fed on northern scouring-rush during the morning when surface soils and water were frozen, and they consumed underground parts of tall cottongrass during afternoon and evening after soils had thawed.

We examined forage intake and digestibility among captive snow geese to better understand the population's forage requirements (Hupp et al. 1996). Snow geese fed for a high percentage of the day (50-60%) and maintained high rates of forage intake (14 g dry matter/hour). On a daily basis a goose probably consumes the equivalent of about 30% of its body mass in cottongrass stembases. A population of 300,000 snow geese that stages for 3 weeks could consume as much as 4,200,000 kg (wet mass) of cottongrass stembases. Thus the population consumes a very large amount of forage in a short period.

Northern scouring-rush primarily grew on riparian terraces within 400 m of river channels. Riparian terraces adjacent to rivers are important habitat for snow geese as they feed on scouring-rush.

We measured vegetation and soil moisture at sites where snow geese fed on tall cottongrass, and then we developed a statistical model to identify suitable feeding habitat (Hupp and Robertson 1998). The model was tested using captive snow geese. Snow geese typically exploited small, homogeneous patches of cottongrass in flooded areas. They avoided uplands and flooded areas where cottongrass was intermixed with *Carex*, shrubs, or tussocks.

The habitat selection model was used to assess the availability of cottongrass feeding sites along 192 randomly located transects on the 1002 Area east of the Hulahula River. Cottongrass feeding sites occurred in

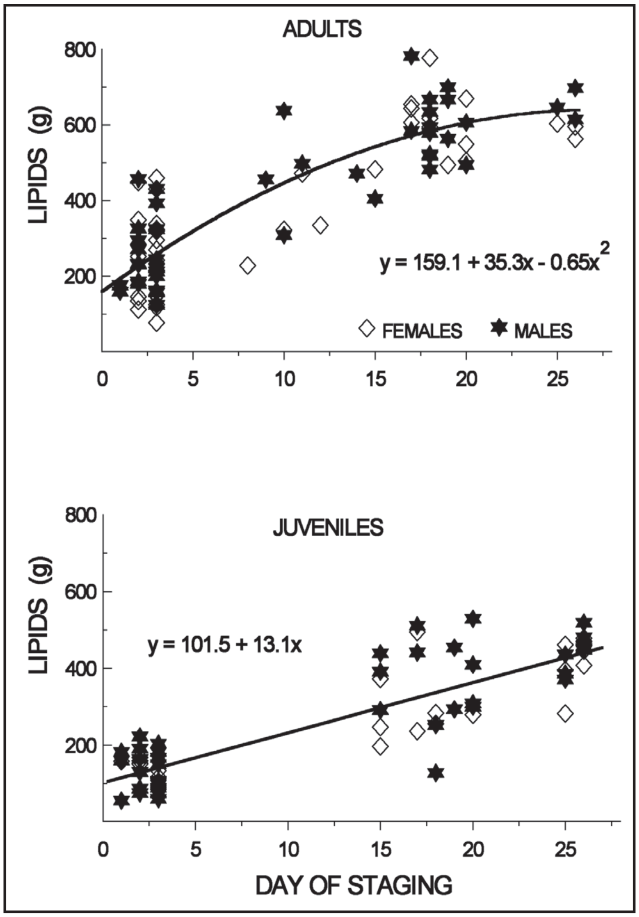

Figure 9.3. Rates of lipid deposition by lesser snow geese during fall staging on the Arctic National Wildlife Refuge, Alaska. Geese were collected in 1984, 1985, and 1988. Data were pooled across years and size of fat reserves scaled to the date geese were first observed on the Arctic Refuge in each year.

small patches that were highly interspersed with less suitable feeding habitat. They were widely distributed but comprised a small percentage (≤3%) of the study area.

Larger-scale micro-relief features were also examined at snow goose feeding areas. Cottongrass feeding sites primarily occurred along narrow (<1 m) edges of flooded thermokarst pits, water tracks, and troughs. When feeding on cottongrass, snow geese selected areas with greater availability of thermokarst pits and avoided uplands, low center polygons, wet meadows, and strangmoor (Hupp and Robertson 1998).

Thermokarst pits and water tracks were widely available in the mid-coastal plain between the Okpilak and the Aichilik rivers. Greater availability of cottongrass feeding habitat in that region likely accounts for its more frequent use by snow geese (Hupp and Robertson 1998).

Snow geese removed the underground portion of cottongrass from which plants regenerate. Four years after an experimental removal, the biomass of stembases in treatment plots was approximately 50% of that in control plots (Hupp et al. 2000). Feeding by snow geese likely reduces forage availability in subsequent years. Geese may be unable to successfully exploit a site for several years after it has been grazed.

Snow geese consume large volumes of forage at feeding sites that are small, patchy, and comprise ≤3% of the landscape. Feeding on cottongrass at a site reduces forage abundance at that location for at least several years. Snow geese in the Western Arctic population use an extensive staging area because forage availability varies both spatially and temporally. Variation in the numbers of staging geese on the Arctic Refuge is likely due to annual differences in habitat conditions. Poor forage conditions or the presence of snowcover on the Canadian portion of the staging area may contribute to greater number of staging geese on the Arctic Refuge.

Effect and Mitigation of Human Activities on Snow Geese

Staging snow geese are easily disturbed by aircraft activity (Davis and Wiseley 1974, Bélanger and Bédard 1989). Repeated aircraft disturbance can reduce their rate of food intake due to disruption of feeding behavior and displacement from feeding habitats. Reduced fat accumulation and diminished survival during migration could result from repeated aircraft disturbance.

The following objectives were designed to assess snow goose response to experimental aircraft overflights: 1) determine the effect of aircraft on activity patterns and habitat use, 2) calculate the effect of increased stress or displacement caused by aircraft overflights on the energy budgets of the geese, and 3) determine implications of petroleum development to survival of snow geese.

Studies of aircraft disturbance were limited due to low numbers of geese on the Arctic Refuge in most years from 1988-1993, poor weather, and the need to meet other study objectives. Snow geese flushed at a mean distance of 5.2 km (SD = 2.9) from a Bell 206B helicopter during overflights in 1991 (n = 19). Flocks were displaced an average of 1.8 km (SD = 2.0) from their feeding sites.

These results are similar to a 1973 study of aircraft disturbance to the Western Arctic population in Canada in which fixed-wing aircraft and helicopters flushed snow goose flocks within a 6-km radius (Davis and Wiseley 1974). In that study, flocks were displaced an average of 1.9, 1.6, and 5.9 km from feeding sites by helicopters, small, and large fixed-wing aircraft, respectively.

Several studies suggest that human disturbance can displace staging snow geese from feeding habitats and possibly diminish the size of juvenile fat reserves. A study of staging greater snow geese found that >2 disturbances/hour caused 50% fewer geese to use the disturbed area the following day (Bélanger and Bédard 1989). Energetic reserves of juvenile snow geese staging on the coast of the Beaufort Sea in Canada were projected to diminish approximately 9-20% if aircraft disturbed birds at least once every 2 hours (Davis and Wiseley 1974).

Brackney (1987) estimated that 20-30 aircraft overflights/day would reduce fat reserves of juvenile snow geese on the Arctic Refuge by up to 50%, assuming geese were unable to increase feeding time to compensate for disturbance. Aircraft disturbance would likely have a greater affect on juvenile snow geese because they spend a higher proportion of the day feeding, accumulate fat reserves at a slower rate, and depart with smaller reserves than adults.

Displacement of geese from feeding areas on the Arctic Refuge is of special concern because feeding habitats are limited (Hupp and Robertson 1998) and a large proportion of the frequently used region is within the 1002 Area (Robertson et al. 1997). The Western Arctic population requires access to the entire staging area on the Arctic Refuge to ensure that it can locate adequate feeding habitat in all years. We cannot assume that snow geese would be able to locate adequate feeding habitat in other regions if they were displaced from the Arctic Refuge coastal plain.

Aircraft activity on the Arctic Refuge coastal plain east of the Hulahula River should be closely managed in the event of petroleum development. During autumn staging, aircraft should be restricted within 6 km of frequently used areas between the Okpilak and Aichilik rivers. Aircraft should be restricted across the entire staging area in years when $\geq$100,000 snow geese are observed on the Arctic Refuge. Surface facilities should not be placed in areas that are frequently used by snow geese.

References

Bélanger, L., and J. Bédard. 1989. Responses of staging greater snow geese to disturbance. Journal of Wildlife Management 53:713-719.

Brackney, A. W. 1987. Effects of aircraft disturbance on the energetics of staging lesser snow geese: a model. Pages 1109-1136 *in* G. W. Garner and P. E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1985 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

_____, and J. W. Hupp. 1993. Fall diet of snow geese staging in northeastern Alaska. Journal of Wildlife Management 57:55-61.

Davis, R. A., and A. N. Wiseley. 1974. Normal behavior of snow geese on the Yukon-Alaska north slope and the effects of aircraft-induced disturbance on this behavior, September 1973. Chapter 2 *in* W. W. Gunn, W. J. Richardson, R. E. Schweinsburg, and T. D. Wright, editors. Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biological Report Series 27.

Hupp, J. W., and D. G. Robertson. 1998. Forage site selection by lesser snow geese during autumn staging on the Arctic National Wildlife Refuge, Alaska. Wildlife Monographs 138:1-40.

_____, _____, and J. A. Schmutz. 2000. Recovery of tall cottongrass following real and simulated feeding by snow geese. Ecography 23:367-373.

_____, R. G. White, J. S. Sedinger, and D. G. Robertson. 1996. Forage digestibility and intake by lesser snow geese: effects of dominance and resource heterogeneity. Oecologia 108:232-240.

Johnson, S. R., and D. R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration (Alaska), Inc., Anchorage, Alaska, USA.

Kerbes, R. H., V. V. Baranyuk, and J. E. Hines. 1999. Estimated size of the Western Canadian Arctic and Wrangel Island lesser snow goose populations on their breeding and wintering areas. Pages 25-37 *in* R. H. Kerbes, K. M. Meeres, and J. E. Hines, editors. Distribution, survival, and numbers of lesser snow geese of the Western Canadian Arctic and Wrangel Island, Russia. Canadian Wildlife Service Occasional Paper 98.

Oates, R. M., M. McWhorter, G. Muehlenhart, and C. Bitler. 1987. Distribution, abundance, and productivity of fall staging lesser snow geese on coastal habitats of northeast Alaska and northwest Canada, 1985. Pages 349-366 *in* G. W. Garner and P. E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment: 1985 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Owen, M., and J. M. Black. 1991. The importance of migration mortality in non-passerine birds. Pages 360-372 *in* C. M. Perrins, J. D. Lebreton, and G. Hirons, editors. Bird population studies: relevance to conservation and management. Oxford University Press, Oxford, England, United Kingdom.

Patterson, L. A. 1974. An assessment of the energetic importance of the North Slope to snow geese (*Chen caerulescens*) during the staging period in September 1973. Chapter 4 *in* W. W. H. Gunn, W. J. Richardson, R. E. Schweinsburg, and T. D. Wright, editors. Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biological Report Series 27.

Robertson, D. G., A. W. Brackney, M. A. Spindler, and J. W. Hupp. 1997. Distribution of autumn-staging lesser snow geese on the northeast coastal plain of Alaska. Journal of Field Ornithology 68:124-134.

Wiseley, A. N. 1974. Disturbance to snow geese and other large waterfowl species by gas-compressor sound simulation, Komakuk, Yukon Territory, August-September, 1973. Chapter 3 *in* W. W. H. Gunn, W. J. Richardson, R. E. Schweinsburg, and T. D. Wright, editors. Studies on snow geese and waterfowl in the Northwest Territories, Yukon Territory, and Alaska, 1973. Arctic Gas Biological Report Series 27.